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HEAT ENGINES OPERATING WITH TWO DIFFERENT FLUIDS WHICH ARE SUBJECTED TO THE SAME TEMPERATURES AND NOVEL APPLICATIONS OF SAID ENGINES

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Serial No. 187,354

2 Sheets-Sheet 1

Fig. 1.

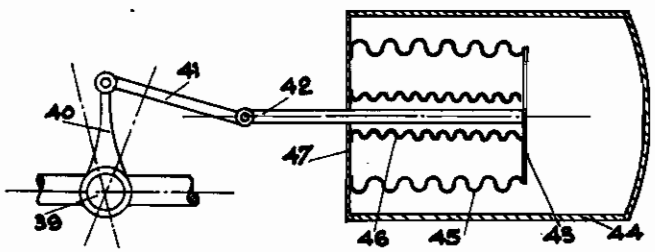

Fig. 2.

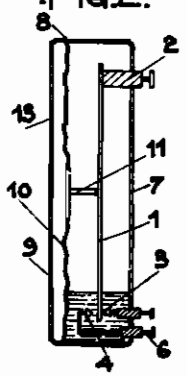

Fig. 3.

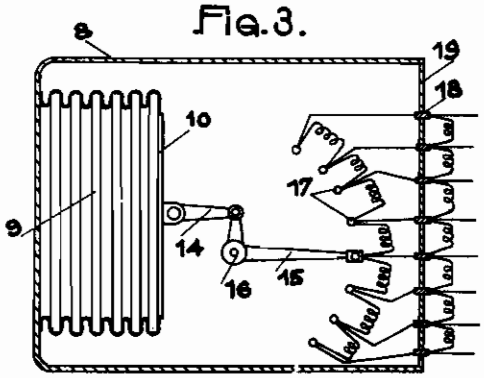

Fig. 4.

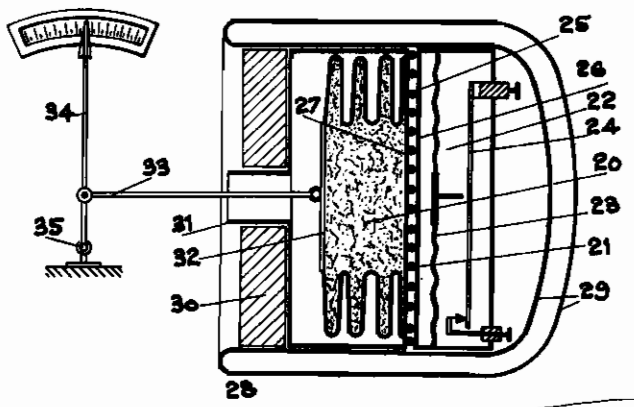

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Fig.5.

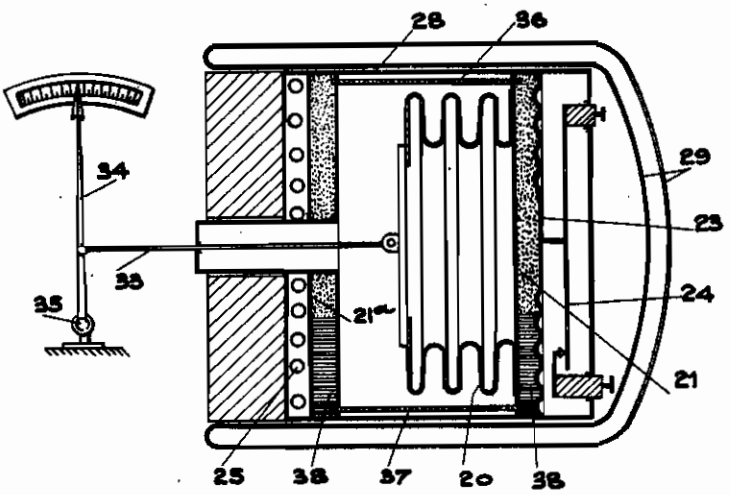
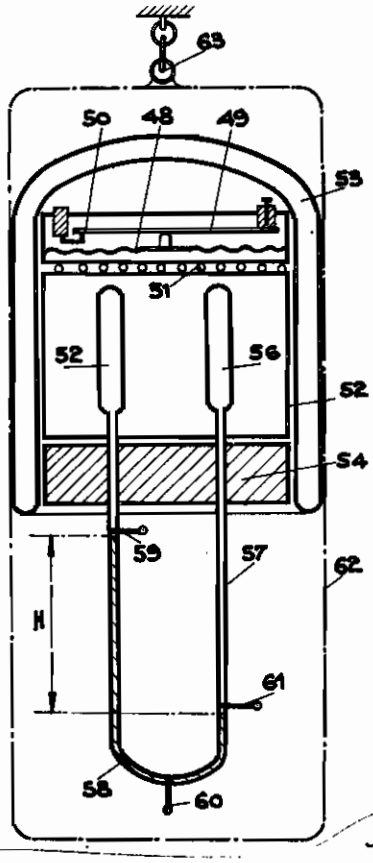


Fig.6.



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HEAT ENGINES OPERATING WITH TWO DIFFERENT FLUIDS WHICH ARE SUBJECTED TO THE SAME TEMPERATURES AND NOVEL APPLICATIONS OF SAID ENGINES

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Application filed January 28, 1938

The present invention, Reutter's system, relates to heat engines which have a movable wall which is common to two fluid-tight chambers each containing a different fluid. The displacements of said wall, which are utilised for producing work, being produced by the variations of the temperature which is common to the two fluids. If the variations of pressure are small, the thrust on the movable wall can be as great as desired since, other things moreover being equal, it is proportional to its area.

Taking advantage of this possibility which enables considerable mechanical energy to be obtained for small variations of temperature of the fluids, the invention relates to the novel application of the heat engines of the kind indicated to the construction of thermostats for the direct control of members or mechanisms in which the resistance energy to be overcome is considerable.

Thus, without decreasing the sensitiveness, considerable strokes and forces can be obtained for relatively small differences of temperature. It is known that the known thermostats, which are all based on the expansion of liquids or of solids, can only be sensitive conditionally on transmitting extremely reduced forces.

The invention also covers the application of the same engines to the construction of electric contact apparatus for controlling circuits from which any desired effects can be obtained. The electric contacts are arranged in one of the chambers of the heat engine with an atmosphere of which the nature and the pressure are chosen to prevent break sparks and arcs and the oxidization or the deterioration of the contacts.

It is possible to use said contacts for controlling the common temperature of the two fluids of the engine. It suffices for this purpose to maintain the temperature of the fluids by means of electric heating resistances the supply of which is placed under the control of the contacts which are actuated by the movable wall of the engine.

The engines thus arranged permit of the realization of accurate pressure gauges and of all apparatus of the same nature such as barometers and altimeters. In these apparatus, by applying the invention, all the elements which are a cause of errors in the known instruments are eliminated. It is known in fact that aneroid pressure gauges and barometers or altimeters are always inaccurate, owing to causes which are inherent to the metal capsule and such as:

Mechanical hysteresis in the resilient deformation of the metal;
Permanent deformations;
Ageing of the metal.

According to the invention, this drawback is overcome by utilising gas-filled capsules of which the temperature is kept constant by the action of electric contacts which are actuated by a heat engine of the kind referred to, a chamber which is in communication with the fluid of which it is desired to measure the pressure being thus kept at the temperature of the capsule by the same means, and the variations of volume of the very thin and very flexible walled capsule exactly expressing the variations of pressure of the surrounding fluid.

The accompanying drawing shows, only by way of examples, embodiments of the above-defined improvements and novel applications.

Fig. 1 is a diagrammatic axial section of a thermostat for the direct control of a cock.

Fig. 2 is an axial section of a heat engine applied to the control of an electric contact-breaker.

Fig. 3 is a similar view to Fig. 2, for a modification of construction.

Fig. 4 is an axial section of an improved apparatus which can be utilised as a pressure gauge, a barometer or an altimeter.

Fig. 5 is a modification of construction of the apparatus of Fig. 4.

Fig. 6 is a vertical axial section of a gravimeter.

In the embodiment of Fig. 1, the novel application has been considered of the heat engines of the kind indicated, to the construction of a thermostat which is used directly for the control of members which offer a considerable resistance energy. In this example, the member to be controlled is a cock **39** of which the plug, which is provided with a lever **40**, is connected by a connecting rod **41** to a rod **42** which is fixed at one end to the movable wall **43** of the heat engine. Said wall **43** is arranged inside a box **44** and the wall **45** is resiliently deformable. The rod **42** is arranged in a deformable sheath **46** which is fluid-tightly fixed to the wall **43** and to the end **47** and is open at its outer end for the passage of the rod **42** which may, on the other hand, be guided rectilinearly by any appropriate means, not shown. With this arrangement an absolute fluid-tightness of the chambers of the heat engine is obtained. By making the area of the movable wall **43** sufficiently great, it is possible, for small variations of temperature, to impart considerable forces to the rod **42**.

The example considered can form a thermostat for central heating installations; said thermostat, which is very sensitive, can act directly on the draught of the furnace of the boiler or on a cold and hot water mixing-valve.

Fig. 2 shows an application, according to the invention, of the heat engines of the kind indicated, to the control of an electric contact-breaker.

The group of the elements of the contact-breaker is arranged in one of the chambers of the engine, said group comprises a deformable resilient blade **1** which is fixed to a terminal **2** and can

oscillate between two contact studs 3 and 4 connected respectively to terminals 5 and 6 which are electrically insulated and are fluid-tightly fixed, as the terminal 2, on the wall 7 of the box 8. The second chamber of the engine is provided at 9 and is separated from the first chamber 8 by a deformable wall 10 which acts, by means of a central push rod 11, on the resilient blade 1 which is mounted in such a manner that, in the absence of any constraint, it touches the stud 4. The chamber 8 contains a saturant vapour, the generating liquid of which is advantageously a transformer oil in sufficient quantity to cover the studs 3 and 4 constantly. The chamber 9 contains a gas or a non-saturant vapour and the respective pressures in the chambers 8 and 9 may be so chosen that, for a temperature less than that at and beyond which the contact 1—4 is to be broken, the wall 10 is pressed against the end 13 of the box 8. The pressure in the chamber 9 being assumed to increase much faster than that in the chamber 8, the sudden break of the contact 1—4 with immediate closing of the contact at 1—3 will be obtained at and beyond a predetermined temperature, or the closing of this latter contact for a predetermined higher temperature.

In the embodiment shown in Fig. 3, the movable wall 10, which separates the two chambers 8 and 9 of the heat engine, is connected by a connecting rod 14 to a friction contact arm 15 which is pivoted at a fixed point 16 and which, for predetermined temperatures, touches the contact studs of a series 17 which is arranged in the box 9 and surrounded by a suitable atmosphere for preventing break sparks and for ensuring the preservation of the contacts (and such, for example, as carbon dioxide under a pressure of 50 to 60 kgs. per square centimeter). It is thus possible to control electric circuits for obtaining, through the intermediary of relays, any desired effects (remote control of temperatures for example). The connection with the contact studs 17 and the outside circuits is effected by means of terminals 18 which are electrically insulated and are fluid-tightly fixed on the end 19 of the box 8.

In the embodiment of Fig. 4, relating to an apparatus which can be used as a pressure gauge, or as a barometer and as an altimeter, a heat engine which is arranged as an automatic contact-breaker is utilised for keeping constant the temperature, which temperature is maintained by electric resistances, both of the gas contained in a manometric capsule 20 and of the gas in which said capsule is immersed and of which it is required to measure the pressure. As the temperature is constant, the variations of volume of the capsule 20 exactly express the variations of pressure of the gas it contains and which correspond to those of the surrounding gas. Said capsule may be constructed with a very thin and very flexible wall, the mechanical strength of which is negligible. The apparatus of the pressure gauge type thus constructed is free from all the drawbacks referred to above in connection with the known apparatus of the same type.

The heat engine has two chambers 21 and 22 with a common deformable wall 23 which acts on the movable blade 24 of a contact-breaker as already explained in connection with Fig. 3. Said contact-breaker controls the supply current of an electric heating resistance 25 which is in close contact with the wall 26 of the engine and the end 27 of the deformable walled manometric capsule 20 contained in a chamber 28 of good heat conductibility and, for example made of copper or of brass. The whole arrangement is placed in a heat insulating case advantageously formed by a Dewar's flask 29 which is closed by a plug 30 made of any appropriate heat insulating material. The chamber 28 is in communication with the atmosphere of which it is desired to measure the pressure, through a tube 31 and the rigid front face 32 of the capsule 20 is connected by a connecting rod 33 to a pointer 34 which is pivoted at 35 and of which the tip moves in front of any appropriate graduation.

In the example of Fig. 5, which is only a modification of construction of the apparatus shown in Fig. 4, the chamber 29, which contains the manometric capsule 20 and which is in permanent communication with the atmosphere of which it is desired to measure the pressure, is in direct contact by means of each of its ends, on the one hand with a saturant vapour chamber 21ª, and on the other hand with a second saturant vapour chamber 21 which forms one of the chambers of the heat engine having a contact-breaker. The same reference numerals designate the same members or the members which correspond with each other in the two Figures 4 and 5. The electric heating resistance 25 is arranged in close contact with the outer end of the chamber 21ª which communicates through tubes 36 and 37 respectively with the upper and lower parts of the chamber 21.

The saturant vapours and their generating liquids 66 being thus in communication from one chamber 21 to the other chamber 21ª, the temperature is absolutely the same in both chambers. Said temperature is kept constant between narrow limits by the action of the contact-breaker 24 which is actuated by the movable wall 23 of the heat engine.

Fig. 6 shows the application, to the construction of a mercury gravimeter, of the heat engine contact-breaker described in particular with reference to Fig. 2. The heat engine having a movable wall 48 and a contact 50 controls the supply of the heating resistance 51 which keeps the temperature constant of a gas enclosed in the fluid-tight chamber 52. Said chamber, together with the engine having a contact-breaker and the resistance 51, is arranged in a Dewar's flask 53 which is closed by a heat insulating plug 54. Two bulbs 55 and 56 are arranged inside the chamber 52 and connected together by a U-tube 57 which contains a column of mercury 58. The pressures of the gases contained in the bulbs 55 and 56 are different, their difference being expressed by the column of mercury of which the height is H. Said height H is proportional to the density of the mercury, to gravity and to the temperature of the bulbs 55 and 56. As said temperature is constant, the density of the mercury is also constant and H then expresses the value of gravity. Terminals 59, 60, 61 enable electric circuits to be closed by the column of mercury, for actuating relays in order to obtain controlling or other effects. Such an apparatus mounted on an aeroplane and suspended by its support on a joint of the Cardan type placed above its centre of gravity can be utilised as a turning indicator on board aeroplanes, centrifugal force acting in that case with gravity. The aforementioned electric circuits can in that case be utilised for actuating any indicating or controlling apparatus.

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